Outcomes and failure factors in surgical treatment for osteochondritis dissecans of the capitellum

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Outcomes and Failure Factors in Surgical Treatment for Osteochondritis Dissecans of the Capitellum

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Structured Abstract and Levels of Evidence

Background: Osteochondritis dissecans (OCD) of the capitellum is an intra-articular lesion and one of the leading causes of permanent elbow disability. The treatment of advanced capitellar OCD remains challenging because of the limited potential of the articular cartilage for self-repair. The purpose of this study was to investigate the outcome of surgical treatment for OCD of the capitellum.

Methods: From 2000 to 2010, 32 male patients who had advanced lesions of capitellar OCD were treated operatively. The mean age of the patients was 14.4 years at the time of surgery. Twenty-nine patients played baseball and 3 played other sports. The lesions were of the centralized type in 9 patients, the lateral type in 4 patients, and the widespread type in 19 patients. For the surgical procedure, osteochondral peg fixation was selected for 13 patients and osteochondral autograft transplantation for 19 patients. Clinical outcome was measured with the elbow rating system including range of motion, and the number of patients who returned to active sports participation within one year following surgery was determined.

Results: The mean total arc of elbow motion increased from 123° ± 17° preoperatively to 132° ± 14° postoperatively. The mean clinical score improved significantly from 133 ± 24 to 177 ± 27. Within the first year after surgery, 81.3% of the patients returned to active sports playing. However, 4 of 8 patients (50%) in which osteochondral peg fixation was performed for lesions of the lateral

widespread type required reoperation.

Conclusions: Our results indicate that osteochondral peg fixation and osteochondral autograft transplantation may improve elbow rating score, and may facilitate a return to active sports participation. However osteochondral peg fixation may be insufficient for lesions of the widespread type because of their poor stability. The large lateral condyle lesions had a worse outcome, and future studies will need to develop improved treatment for these defects.

Level of Evidence: Level Ⅳ (case series).

Key Words:

osteochondritis dissecans, humeral capitellum, surgical treatment, osteochondral transplantation

Text

Introduction:

Osteochondritis dissecans (OCD) of the humeral capitellum is observed primarily in adolescent athletes, especially in baseball players, and is a very difficult condition to treat. Repetitive valgus stress occurs during the late cocking and acceleration phases of the throwing motion. Valgus and terminal pronation of the elbow cause combined compressive and shearing forces to the humeral capitellum and radial head across the radiocapitellar articulation. Throwing can cause fatigue of the medial elbow complex, specifically, of the medial collateral ligament and flexor pronator origin, which increases these forces.[1,2] This cyclic microtrauma to articular cartilage can result in a fatigue fracture, avascularity, and subchondral fragment separation.[3] Because inadequate procedures for the treatment of OCD potentially lead to osteoarthritis and poor functional outcomes[4], appropriate clinical decisions are important, especially for patients who present in an advanced stage.

The purpose of the present study was to investigate the outcome of surgical treatment for OCD of the humeral capitellum and to analyze the causes for poor clinical results that lead to a need for reoperation.

Materials and Methods:

From 2000 to 2010, 32 male patients who had advanced OCD of the capitellum were treated operatively. All patients had been engaged in competitive sports and were unable to perform their sports activities at the time of surgery because of severe elbow pain. The mean age of the patients was 14.4 years (range, 10-18) at the time of surgery. Twenty-nine patients played baseball and three played other sports (basketball, dodgeball, and tennis). Baseball players included 14 pitchers, eight infielders, four catchers, two pitchers/infielders, and one catcher/infielder. All patients were right-hand dominant, and the dominant side elbow was affected in all patients.

At the initial examination, bilateral radiographs of the elbows, consisting of an anteroposterior view in full extension, lateral view, and anteroposterior view with the elbow in 45° flexion, were performed on all patients. Radiographic findings classified the capitellum into three grades: grade 1 indicated localized flattening and/or radiolucency; grade 2, a nondisplaced fragment; and grade 3, a displaced fragment[2,4,5] (Fig. 1). On the basis of the magnetic resonance imaging (MRI) criteria of unstable OCD lesions described by Kijowski et al.[6], subjects in grade 2 divided into early and late stages; the presence of a high-signal-intensity line beneath the lesion in T2-weighted images indicated an unstable lesion and the subject was classified into the late detached stage. Therefore, the subjects were classified into four stages: the translucent stage, the early detached stage, the late detached stage, and the displaced stage.

In addition, on the basis of the site of the focal lesion, subjects were divided into a centralized type and a lateral type. Furthermore, the lateral type was divided into a lateral localized type (less than 33% of the width of the capitellar articular surface) or a lateral widespread type (more than 33%) (Fig. 2).

Our broad management of OCD of the capitellum depended on the stage and type of lesion. For patients with stable lesions in the translucent stage, conservative treatment or drilling to the lesion was selected. For patients with lesions in the early detached stage, the option of osteochondral peg fixation was added. For patients with lesions in the late detached stage, osteochondral peg fixation or reconstruction of the articular surface with use of osteochondral autograft from the knee [osteochondral autograft transplantation (e.g. mosaicplasty)] was performed. When the lesion was in the displaced stage, we selected osteochondral autograft transplantation (Fig. 3). Although the surgical method was planned preoperatively using radiography and MRI, the surgical procedure was finally determined based on the direct confirmation of the lesion during surgery.

Postoperatively, the patient's elbow was immobilized in neutral position for a week. At two weeks after operation, the patient began active and assisted passive range of motion exercises. Strengthening exercises of the elbow and forearm were allowed at four weeks postoperatively. Three months after the operation, patients began throwing activity. The patients were allowed to return to their previous level of throwing activity 6 to 10 months postoperatively.

111 Clinical outcome was measured with the subjective and objective elbow rating system previously
112 reported by Timmeman and Andrews[7] (Table 1). The clinical rating system consisted of both
113 subjective (pain, swelling, locking and/or catching, and activities) and objective (range of motion)
114 evaluations. On the basis of the clinical scores, overall clinical results were classified into the
115 following four categories: excellent (a score of 180 to 200), good (a score of 160 to 179), fair (a score of
116 120 to 159), or poor (a score of <120). All patients were assessed for any disturbances in the donor
117 knee and asked about return to sports during an interview.
118 The data were analyzed using Statistical Package for the Social Sciences (SPSS) for Windows
119 Version 19.0 (SPSS Inc; Chicago, IL, USA). A Wilcoxon signed rank test was performed to compare
120 the differences between pre- and postoperative range of motion, and the rating score before and
121 after surgery. Values of $p < .05$ were considered statistically significant.
122 All patients and their families were informed that data from their cases would be submitted for
123 publication, and provided informed consent. This study was approved by the ethics committee of our
124 university.

Results:

Radiographs and MRI showed the early detached stage in seven elbows, the late detached stage in 15 elbows and the displaced stage in 10 elbows. No subject in the present series was found in the translucent stage. The lesions were of the centralized type in nine patients, the lateral localized type in four patients, and the lateral widespread type in 19 patients. For the surgical procedure, osteochondral peg fixation was performed for 13 patients and osteochondral autograft transplantation was performed for 19 patients. For the centralized type cases, osteochondral peg fixation was performed for one patient and osteochondral autograft transplantation was performed for eight patients. For the lateral localized type cases, osteochondral peg fixation was performed for three patients and osteochondral autograft transplantation was performed for one patient. For the lateral widespread type cases, osteochondral peg fixation was performed for nine patients and osteochondral autograft transplantation was performed for 10 patients (Table 2).

The mean duration of follow-up was 58.6 months (range, 24 to 146 months). The preoperative mean ranges of motion were 128.9 ± 10.2 degrees flexion and -6.4 ± 11.9 degrees extension. Postoperatively, mean ranges of motion improved to 136.3 ± 8.9 degrees flexion and -4.7 ± 7.8 degrees extension. Compared with preoperative ranges of motion, improvement in flexion was statistically significant ($p = 0.002$), but there was no statistical difference between pre- and postoperative ranges of motion in extension ($p = 0.658$).

Preoperatively, the mean subjective score was 56 ± 11 (pain, 11; swelling, 19; locking, 15; activity, 12) and the mean objective score was 76 ± 18 (flexion contracture, 16; pronation/supination, 24; and sagittal arc of motion, 36, respectively). At the follow-up, the postoperative mean subjective score improved significantly to 89 ± 15 (pain, 21; swelling, 24; locking, 23; activity, 21) ($p < 0.001$). The mean postoperative objective score was 88 ± 14 (flexion contracture, 20; pronation/supination, 25; and sagittal arc of motion, 43, respectively). There was a significant difference between pre- and postoperative objective scores ($p = 0.005$). The mean clinical total score improved significantly from 133 ± 24 preoperatively to 177 ± 27 postoperatively ($p < 0.001$). The overall evaluation was excellent in 20 patients, good in nine patients, fair in two patients, and poor in three patients at the follow-up.

Within the first year after surgery, 26 of the 32 patients (81.3%) returned to active sports playing. In addition, none of the donor knees which were removed of osteocartilaginous tissues experienced negative effects.

Four patients, including three rated as “poor”, had poor stability and were observed with free bodies. In these four cases, a second surgery was performed on average 18.5 months (range: 7 to 32 months) after the first surgery. All surgeries were performed with osteochondral peg fixation for the lateral widespread type of lesion at the late detached stage. In addition, osteochondral autograft transplantation was performed for three patients and only free bodies were removed for one patient

161 in this group for a personal reason.

Discussion:

OCD of the capitellum is an intra-articular lesion that is one of the leading causes of permanent elbow disability. It occurs most commonly in athletes who use their arms for throwing activities. It may affect not only sports activities, but also activities of daily living. In general, early-stage OCD is managed conservatively, and good outcomes are usually achieved.[4,8] On the other hand, advanced OCD lesions generally require surgical management. Because of the limited potential of the articular cartilage for self-repair, the treatment of advanced capitellar OCD lesions is challenging. Various surgical methods for treatment of capitellar OCD have been reported, including removal of free fragments, marrow stimulation involving drilling and abrasion arthroplasty, closed wedge osteotomy of the capitellum, reattachment of the fragments, and osteochondral autograft transplantation.[2,4,9-15]

In recent years, excellent results for treatment of capitellar OCD have been reported. Yamamoto et al.[13] performed osteochondral autograft transplantation for 18 capitellar OCD in juvenile baseball players and reported that 78% of athletes recuperated to their former level with a mean follow-up of 3.5 years. Mihara et al.[14] reported that 92.6% of those who underwent osteochondral peg fixation and mosaicplasty returned to baseball. The competition return rate in our department was 81.8%, comparable to the previous reports.

However, four out of 32 OCD cases performed in our department had a second surgery. All four

cases had the lateral widespread type of lesion at the late detached stage, and surgery was performed with osteochondral peg fixation. Therefore, four out of eight (50%) lateral widespread type cases at the late detached stage performed with osteochondral peg fixation had to undergo a second surgery.

It has been reported that poor outcomes of OCD surgery arise from several causes such as pre-existing osteoarthritic changes, subluxation of the radial head, and poor lateral margin of the widespread type.[15] In particular, Mihara et al.[14] stated that the large and unrestored lesion of the lateral margin of the capitellum is predictive of poor prognosis. In this study, all the cases that underwent a second surgery were the lateral widespread types. Reconstruction of the strong lateral margin of the capitellum is important in OCD surgery.[14,15] In the surgery of the lateral widespread type, the destruction of the lateral wall of the capitellum tends to make the lateral margin unstable and difficult to fix in the ideal manner. As a result, support is insufficient and the cartilage fragments come apart and proceed to osteoarthritic changes or free bodies. Therefore, we speculated that worse outcomes are seen in larger, lateral-based, poorly contained lesions. It is thought that it is necessary to reconstruct the firm lateral margin of the humeral capitellum and to operate with appropriate methods that produce stable fixation, such as osteochondral or costochondral autograft transplantation.

The articular surface of the hyaline cartilage is repairable with costochondral graft that includes

198 cortical and cancellous bone. This can be performed at the same time, and the arthroplasty is easy
199 even if the lateral wall is broken.[16] However, the surgical technique sometimes becomes complicated.
200 In these procedures, it is very difficult to insert large-diameter autografts perpendicularly into the
201 capitellum of the humero-radial joint which has a small, narrowly restricted operative field. It is
202 axiomatic that it is difficult to prevent osteoarthritic change of the lateral widespread type cases[17],
203 but sometimes it is manageable by devising a way to transplant the osteochondral autograft with
204 the plug facing as squarely as possible to the articular surface of the radial head. Therefore,
205 osteochondral autograft transplantation for those lateral widespread type cases would be facilitated
206 by a device that allows placement of the graft at the proper angle. For example, Miyamoto et al.[18]
207 reported that the oblique transplantation technique allows appropriate insertion of osteochondral
208 autografts into recipient holes in a restricted operative field, even if the OCD lesion is located in the
209 lateral site. Nevertheless, how to deal with the lateral margin lesion that seems to be more
210 troublesome remains a challenging problem, and improved techniques will need to be developed to
211 treat defects in this area.
212 A considerable disadvantage in performing osteochondral autograft transplantation is the potential
213 adverse effect on the donor sites. In this procedure, we harvest small cylindrical grafts from the
214 non-weight-bearing area of the femoral condyles and routinely leave the harvest sites empty. There
215 have been some studies focusing on donor-site morbidity after harvest of osteochondral

autograft.[19,20] Iwasaki et al.[19] reported that although MRI indicates that the donor site is partially filled and resurfaced with fibrous tissue, no adverse effects of osteochondral graft harvest on donor knee function were found after osteochondral autograft transplantation for capitellar osteochondritis dissecans in young athletes. On the other hand, Reddy et al.[20] suggested that osteochondral harvest from normal knees for the treatment of talar osteochondral lesions led to a decline in knee function. In the present study, no apparent complications on the donor knee were found in any patients. A longer duration of follow-up with a greater number of subjects is needed to better understand the donor knee function and morbidity after osteochondral graft harvest.

The present study has some limitations, including the relatively small number of patients, with too few patients in each sub-category to compare and short period of clinical follow-up. While the clinical findings at the time of follow-up showed favorable and stable outcomes, a larger study with longer follow-up and image-based investigation are needed to confirm whether the lesions will reveal fragment instability and osteoarthritic change. Furthermore, the present study was retrospective and the patients were not randomized. Because it was not prospective, recall and observational biases were unavoidable. In the present study, neither post-operative arthroscopy nor histological examination of the grafted areas was performed. Therefore, we could not directly demonstrate hyaline repair of the OCD lesions.

In conclusion, our results may indicate the efficacy of osteochondral peg fixation and osteochondral

234 autograft transplantation for the treatment of advanced capitellar OCD lesions. Positive outcomes
235 included expanded range of motion, improved elbow ratings, and a return to sports within a year
236 post-operatively. However, four of eight patients (50%) in which osteochondral peg fixation was
237 performed for lesions of the lateral widespread type required reoperation. OCD lesions that involve
238 a significant portion of the lateral column remain a challenging problem, and improved techniques
239 will need to be developed to treat defects in this area.

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286 **Figure Legends**

287

288 FIGURE 1. Anteroposterior plain radiographs of three elbows with osteochondritis dissecans (OCD)
289 of the capitellum. A, A lesion in grade 1: localized flattening and radiolucency. B, A lesion in grade 2:
290 a nondisplaced fragment. C, A lesion in grade 3: a displaced fragment.[2,4,5]

291

292 FIGURE 2. Schema showing the classification on the basis of the site of the focal lesion. A, A lesion
293 in the center of the capitellum (centralized type). B, A lesion in the lateral portion of the capitellum
294 (lateral localized type). C, A lesion laterally-extended more than 33% of the width of the capitellar
295 articular surface (lateral widespread type).

296

297 FIGURE 3. A 13-year-old baseball player. A, Preoperative radiography demonstrates a lesion in the
298 displaced stage and a defect in the intra-articular surface (white arrow). Osteochondral autograft
299 transplantation was performed. B, Radiography at 12 months postoperatively demonstrates healing
300 of the lesion.

301

302 TABLE 1. Rating System for Elbow Joint[7]

Scoring system	Points
Subjective	
Pain	
None	25
Occasional	20
With moderate activity	10
With activities of daily living	5
Swelling	
None	25
Occasional with heavy activity	20
With moderate activity	10
With any activity	5
Locking/catching	
None	25
Rare	20
Occasional	10
Frequent	5
Activities	
No limit	25
Occasional limit	20
Partial activities only	10
Difficulty with activities of daily living	5
Objective	
Flexion contracture	
<5°	25
5°-15°	20
16°-35°	10
>35°	0
Pronation/supination	
Normal	25
<30% decrease in total arc	20
<50% decrease in total arc	10
>50% decrease in total arc	0
Sagittal arc of motion	
>130°	50
120°-130°	40

110°-119°	30
100°-109°	20
75°-99°	10
60°-74°	5
<60°	0
Overall rating	
Excellent	180-200
Good	160-179
Fair	120-159
Poor	<120

303

304

TABLE 2. Distribution of Patients

	No. of Elbows	Mean Age (yr)	Stage of Lesion: Early Detached Stage	Stage of Lesion: Late Detached Stage	Stage of Lesion: Displaced Stage
Total	32	14.4	7	15	10
Sports played					
Baseball	29	14.3	6	14	9
Other	3	15.3	1	1	1
Operative Treatment					
OPF	13	13.8	2	9	2
OAT	19	14.7	5	6	8

(continued)

Site of Lesion: Centralized Type	Site of Lesion: Lateral Localized Type	Site of Lesion: Lateral Widespread Type
9	4	19
7	3	19
2	1	0
1	3	9
8	1	10

All patients are male athletes.

OPF indicates osteochondral peg fixation; and OAT, osteochondral autograft transplantation.

FIGURE 1.

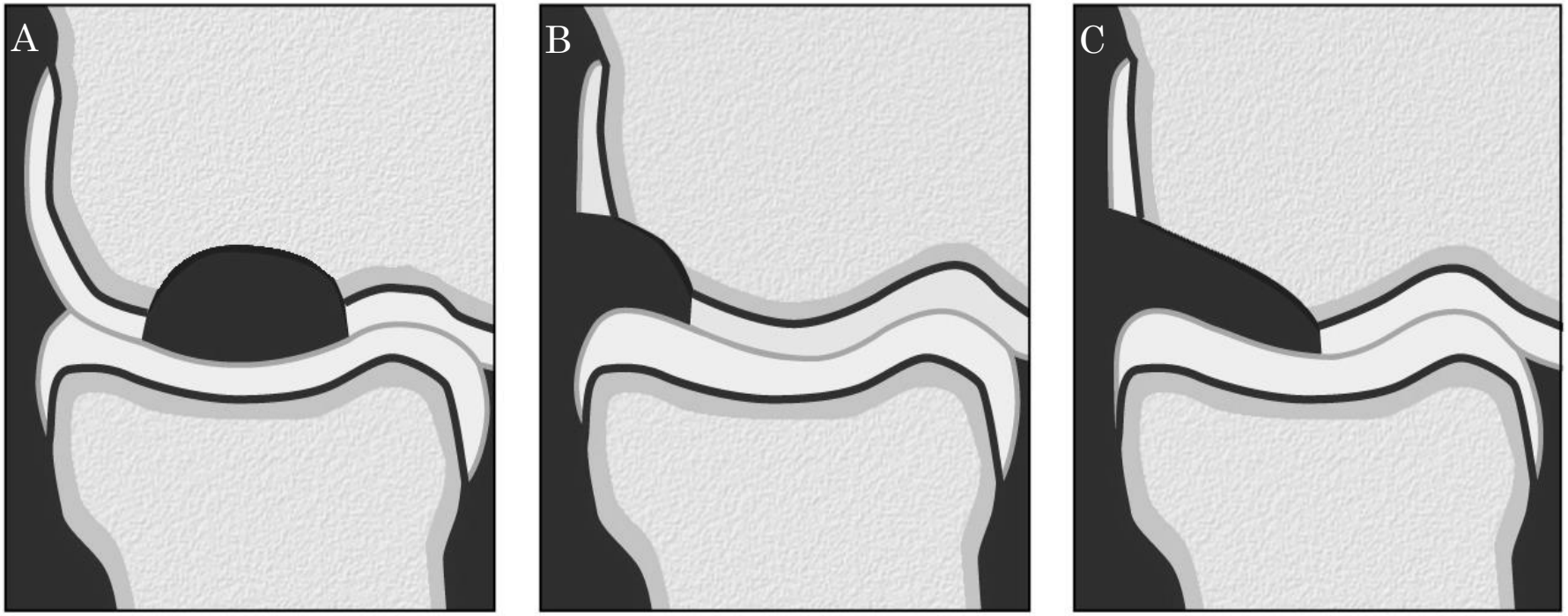

FIGURE 2.

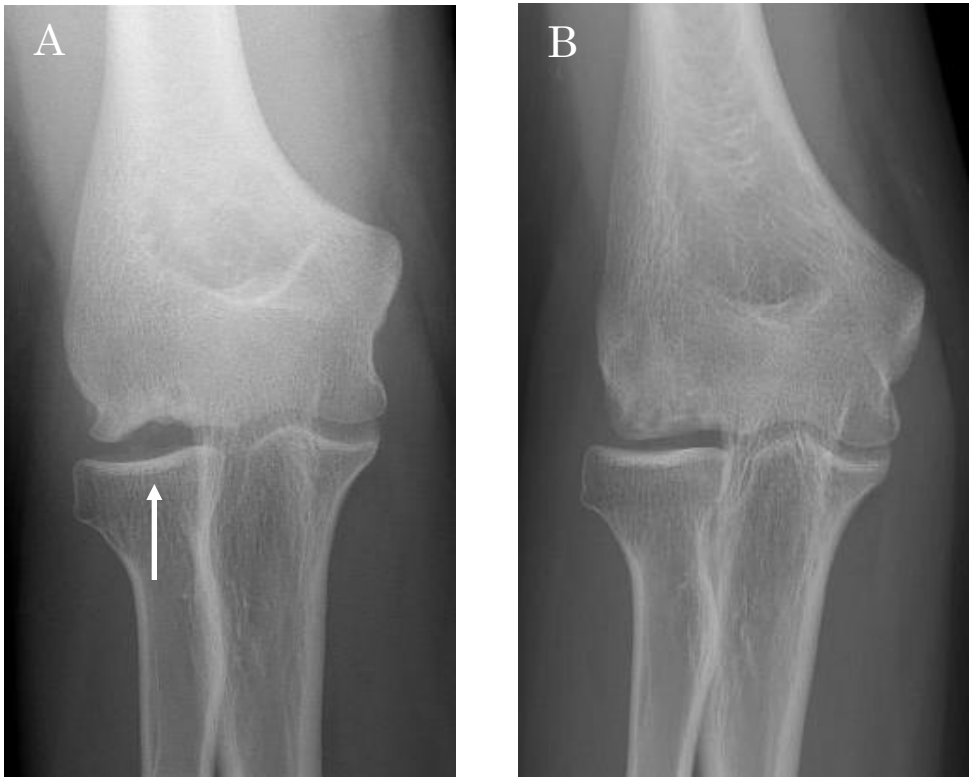

FIGURE 3.